US008151887B2

(12) **United States Patent**
DCosta et al.

(10) **Patent No.: US 8,151,887 B2**
(45) **Date of Patent: Apr. 10, 2012**

(54) **LUBRICATOR VALVE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 640 days.

(21) Appl. No.: **11/851,173**

(22) Filed: **Sep. 6, 2007**

(65) **Prior Publication Data**

US 2009/0065212 A1 Mar. 12, 2009

(51) **Int. Cl.**
E21B 34/00 (2006.01)

(52) **U.S. Cl.** **166/319**; 166/368; 166/373; 166/332.3; 251/315.01

(58) **Field of Classification Search** 166/368, 166/339, 344, 345, 352, 367, 373–375, 381, 166/386, 86.1, 316, 319, 332.2, 332.3; 251/315.01
See application file for complete search history.

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(57) **ABSTRACT**

A lubricator valve assembly adapted for connection in a pipe string for use in a well includes a tubular valve body having a bore formed longitudinally therethrough; a valve seat connected to the valve body and in communication with the bore; a valve element mounted in the bore and rotatable with respect to the valve seat between positions opening and closing the bore; an operator in connection between the valve element and a hydraulic control system, the operator moving the valve element between the open and close bore positions in response to the hydraulic control system; and a system for opening the valve element upon failure of the hydraulic system.

15 Claims, 2 Drawing Sheets

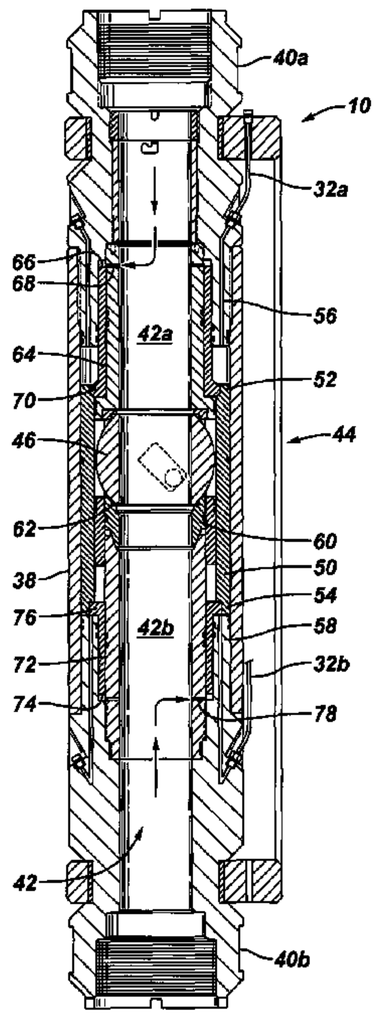


FIG. 1

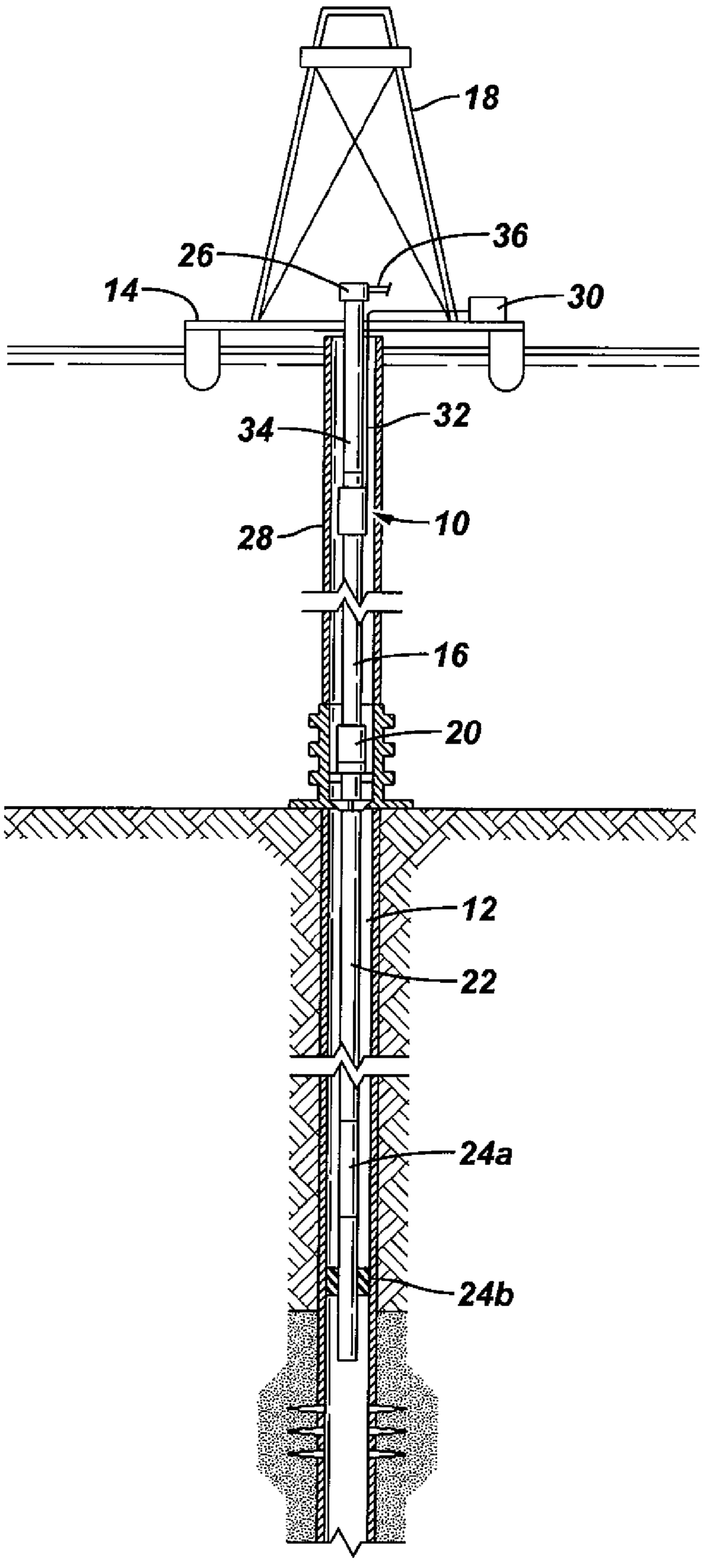
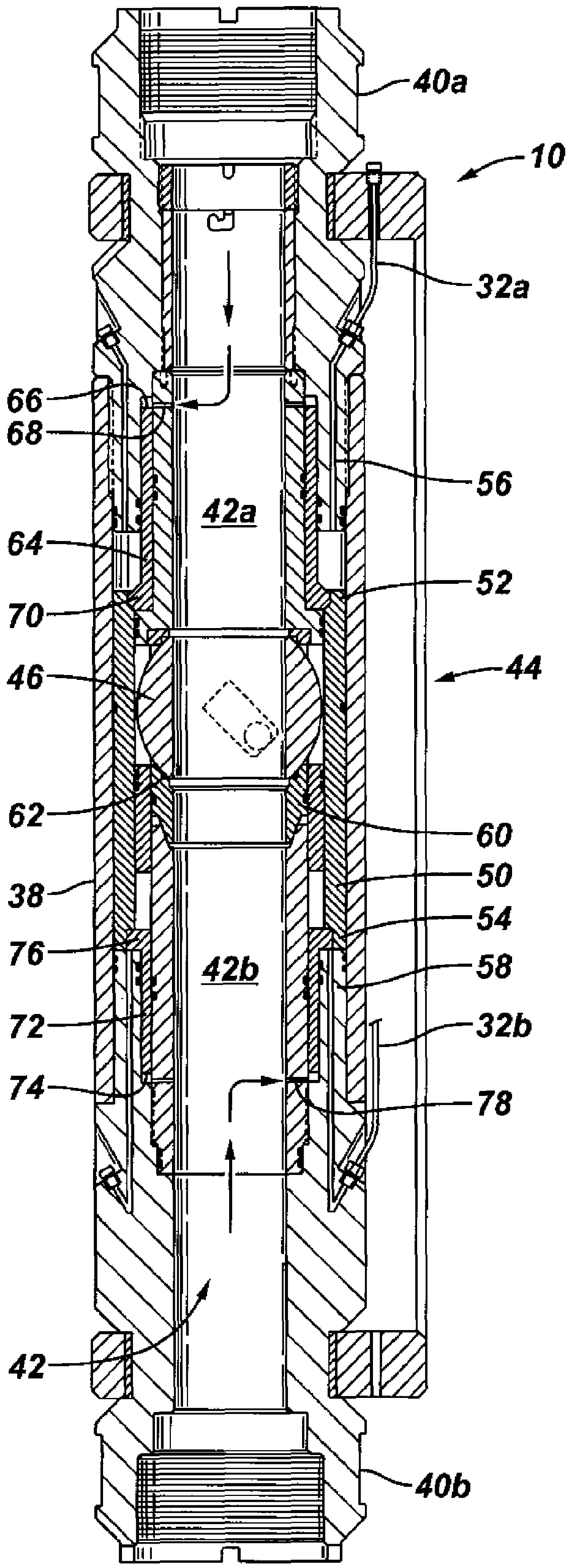


FIG. 2


40a
10
32a
66
68
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42a
64
52
70
44
46
62
60
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38
54
76
58
42b
72
32b
74
78
42
40b

LUBRICATOR VALVE

TECHNICAL FIELD

The present invention relates in general to wellbore operations and more specifically to a lubricator valve having pump-through functionality for restoring access to the wellbore during a closed valve failure.

BACKGROUND

Lubricator valves commonly located in pipe strings above the subsea test tree and below the flowhead are remotely controlled by hydraulic lines in a manner such that the operator can introduce wireline or coiled tubing tools into the well. It is highly desirable to provide a mechanism to pump-through or open the valve upon the failure of the hydraulic system or control system for the valve.

Therefore, it is a desire to provide a lubricator valve with pump-through functionality.

SUMMARY

In view of the foregoing and other considerations, the present invention relates to a lubricator valve with pump-through functionality.

Accordingly, a lubricator valve assembly adapted for connection in a pipe string for use in a well includes a tubular valve body having a bore formed longitudinally therethrough; a valve seat connected to the valve body and in communication with the bore; a valve element mounted in the bore and rotatable with respect to the valve seat between positions opening and closing the bore; an operator in connection between the valve element and a hydraulic control system, the operator moving the valve element between the open and close bore positions in response to the hydraulic control system; and a system for opening the valve element upon failure of the hydraulic system.

In a well completion having a pipe string extending from a wellhead into a wellbore and a lubricator valve connected in the pipe string for intervening in the wellbore, the lubricator valve includes a body having a longitudinal bore; a valve seat; a ball element mounted in the bore and rotatable with respect to the valve seat between positions opening and closing the bore, the valve seat positioned below the ball element relative to the wellhead; an operator in connection between the ball element and a hydraulic control system, the operator moving the ball element between the open and close bore positions in response to the hydraulic control system, the operator not in fluid communication with the bore; and a means for pumping-through the lubricator valve when the ball element is in the closed position, the pump-through means including a pump-through piston having a first end connected to the operator and a second end in fluid communication with the bore above the ball element and a counter piston having an end connected to the operator and a second end in fluid communication with the bore below the ball element.

The foregoing has outlined some of the features and technical advantages of the present invention in order that the detailed description of the invention that follows may be better understood. Additional features and advantages of the invention will be described hereinafter which form the subject of the claims of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features and aspects of the present invention will be best understood with reference to the following detailed description of a specific embodiment of the invention, when read in conjunction with the accompanying drawings, wherein:

FIG. **1** is a schematic of an offshore well utilizing a lubricator valve of the present invention; and

FIG. **2** is a partial cross-sectional view of a lubricator valve of the present invention.

DETAILED DESCRIPTION

Refer now to the drawings wherein depicted elements are not necessarily shown to scale and wherein like or similar elements are designated by the same reference numeral through the several views.

As used herein, the terms "up" and "down"; "upper" and "lower"; and other like terms indicating relative positions to a given point or element are utilized to more clearly describe some elements of the embodiments of the invention. Commonly, these terms relate to a reference point as the surface from which drilling operations are initiated as being the top point and the total depth of the well being the lowest point.

FIG. **1** is a schematic of an offshore well **12** utilizing a lubricator valve **10** of the present invention. Well **12** is being drilled from a vessel **14** such as a platform, rig or ship. A pipe string **16** extends from the vicinity of the rig floor of a derrick **18** to a subsea control valve **20**. A lower pipe string **22** is suspended from the control valve **20** and may have connected thereto a series of well tools such as a tester valve **24***a* and a packer **24***b*. A wellhead **26** is connected to the upper end of pipe string **16** at the rig floor of derrick **18**.

In accordance with the present invention, lubricator valve **10** is connected in pipe string **16** about 60 to 150 feet (18 to 47 meters) below the rotary inside of the riser **28**. Lubricator valve **10** is hydraulically controlled from a station **30** through two hydraulic lines **32** that are selectively pressurized to cause valve **10** to open and close as desired. Lubricator valve **10** enables the top pipe string portion **34** to be used as a lubricator during intervention operations when running tool strings **36** such as wireline or coil tubing strings.

In some embodiments, lubricator valve **10** is a fail-as-is valve with pump-through capability. By "fail-as-is" it is meant that valve **10** remains in its actuated position, open or closed, upon failure of the hydraulic system. The pump-through functionality of valve **10** is the mechanism for restoring access to well **12** when valve **10** fails in the closed position. In embodiments of the present invention the valve may be opened by above ball bore pressure acting on a piston.

The pump-through piston alone facilitates pump-through at high ball pressure differentials between the pressure above the ball and below the ball in the range of 600-8,400 psi. It is further identified that pump-through functionality can be achieved for low differential ball pressure, for example 300 to 500 psi, by the addition of a balance piston in addition to the pump-through piston.

Refer now to FIG. **2** wherein a partial cross-sectional view of an embodiment of lubricator valve **10** is provided. Lubricator valve **10** includes a body or housing **38** including upper and lower subs **40***a*, **40***b*, a central flow passage or bore **42**, and a valve assembly **44** for controlling fluid flow through bore **42**. Subs **40** are adapted for connecting lubricator valve **10** in pipe string **16**. Upper and lower centralizers may be provided to protect the hydraulic lines **32** that run along side of lubricator **10**.

Valve assembly **44** includes a full-opening element such as ball element **46** for controlling fluid flow. Ball element **46** is connected to body **38** and positioned such that bore **42** is divided into an upper bore **42***a* and a lower bore **42***b*. As is

known in the art, upper bore **42***a* is the portion of the bore between the surface or wellhead **26** and ball element **46** and lower bore **42***b* is on the other side of ball element **46**.

Ball valve assembly **44** includes a seal retainer **60** connected within tubular body and positioned below ball element **46**. Thus the ball seat **62** is formed on the lower, or below ball, side of the ball element **46**. Ball element **46** is rotatable in relation to ball seat **62** between positions opening and closing bore **42**. Ball seat **62** is the primary mechanism for preventing fluid communication across ball **46**. In the prior art lubricator valve assemblies, the ball seal is formed on the top side of the ball (e.g., above ball).

A valve or ball operator **50** is connected to ball element **46** for moving the ball between an open and closed position. Operator **50** has an upper end **52** facing the above ball end of lubricator **10** and a lower end **54** facing the below ball end of lubricator **10**. Open hydraulic line **32***a* is hydraulically connected to operator upper end **52** through a path **56**. Similarly, close hydraulic line **32***b* is hydraulically connected to lower end **54** of operator **50** through a path **58**. It is noted that operator ends **52**, **54** are not open to bore **42** and therefore are not affected by the debris in the fluid in bore **42**. Lubricator valve **10** may be operated between the open and closed position via hydraulic pressure transmitted through lines **32** acting on the faces of operator ends **52**, **54**.

In the event of a loss of hydraulic control of ball assembly **44**, due to hydraulic line **32** breakage or the like, it is often necessary to establish a flow path through bore **42** and ball element **46**. To establish the flow path pressure is applied from the surface into above ball portion **42***a*. Lubricator valve **10** is of a unique design to provide this pump-through functionality at various differential pressures across ball **46**.

In a first example, lubricator valve **10** includes an upper, above ball, or pump-through piston **64** to provide pump-through functionality. Upper piston **64** has an end face **66** that is in fluid and pressure communication with above ball bore portion **42***a* via a passage **68**. Upper piston **64** has an operator end **70** that is connected to the above ball operator end **52** of ball operator **50**. In operation, pressure is provided through pipe string **16** (FIG. **1**) into bore portion **42***a* and acts on ball operator **50** via upper piston **64** as shown by the arrow.

Implementation and utilization of upper piston **64** alone provides pump-through functionality at high differential pressure across ball element **46**. For example, upper piston **64** alone may provide pump-through functionality for pressure differentials across ball **46** ranging from about 635 psi to 8,308 psi. It is understood and believed that the pump-through functionality is available at higher differential pressures as well.

Lubricator valve **10** may further include a lower piston **72**, also referred to as a balance piston herein, to provide an expanded range of pressures for pump-through functionality. This example of lubricator valve **46** is believed to provide pump-through functionality at pressure below ball **46** ranging from zero psi to at least 12,500 psi. Additionally, the pressure differential across the valve will remain relatively low, for example 0 to 500 psi for a common size lubricator valve.

Balance piston **72** includes an end face **74** and an operator end **76**. End face **74** is in fluid and pressure communication with the below ball portion of bore **42**, in this example, through passage **78** as shown by the arrow. Operator end **76** is connected to lower end **54** of operator **50**.

From the foregoing detailed description of specific embodiments of the invention, it should be apparent that a lubricator valve with pump-through functionality that is novel has been disclosed. Although specific embodiments of the invention have been disclosed herein in some detail, this has been done solely for the purposes of describing various features and aspects of the invention, and is not intended to be limiting with respect to the scope of the invention. It is contemplated that various substitutions, alterations, and/or modifications, including but not limited to those implementation variations which may have been suggested herein, may be made to the disclosed embodiments without departing from the spirit and scope of the invention as defined by the appended claims which follow.

What is claimed is:

1. A lubricator valve assembly adapted for connection in a pipe string for use in a well, the assembly comprising:

a tubular valve body having a bore formed longitudinally therethrough;

a valve seat connected to the valve body and in communication with the bore, wherein the valve seat is located below a valve element relative to the top of the well, wherein the valve element is mounted in the bore and rotatable with respect to the valve seat between an open position opening the bore to fluid flow across the valve seat and a closed position blocking fluid flow at the valve seat thereby closing the bore;

an operator in connection between the valve element and a hydraulic control system, the operator moving the valve element between the open position and the closed position in response to the hydraulic control system; and

means for opening the valve element upon failure of the hydraulic system, wherein the opening means comprises:

a pump-through piston having a first end connected to the operator and a second end in fluid communication with the bore on a first side of the valve element; and

a counter piston having an end connected to the operator and a second end in fluid communication with the bore on a second side of the valve element opposite from the first side.

2. The assembly of claim **1**, wherein the operator is not in fluid communication with the bore.

3. The assembly of claim **1**, wherein the valve element is moved to the open position upon the application of pressure in the bore acting on the pump-through piston.

4. The assembly of claim **1**, wherein the second end of the pump-through piston is in fluid communication with the bore on the side of the valve element opposite from the valve seat.

5. The assembly of claim **4**, wherein the operator is not in fluid communication with the bore.

6. A well completion having a pipe string extending from a wellhead into a wellbore and a lubricator valve connected in the pipe string for intervening in the wellbore, the lubricator valve comprising:

a body having a longitudinal bore;

a valve seat positioned below a ball element relative to the wellhead, wherein the ball element is mounted in the bore and rotatable with respect to the valve seat between an open position opening the bore to fluid flow across the valve seat and a closed position blocking fluid flow at the valve seat thereby closing the bore; and

a means for pumping-through the lubricator valve when the ball element is in the closed position, wherein the pump-through means comprises:

a pump-through piston functionally connected to the ball element and in fluid communication with the bore above the ball element; and

a counter piston functionally connected to the ball element and in fluid communication with the bore below the ball element.

7. The lubricator valve of claim 6, wherein the ball element is moved to the open position in response to an above ball bore pressure.

8. The lubricator valve of claim 6, wherein the pump-through means functions to operate the ball element to the open position when a pressure differential across the ball element is in the range of 600 psi to 8,400 psi.

9. The lubricator valve of claim 6, wherein the pump-through means operates to move the ball element to the open position in response to a pressure in the bore above the ball element.

10. The lubricator valve of claim 6, wherein the pump-through means functions to move the ball element to the open position in response to a pressure in the bore above the ball element, when a pressure differential across the ball element is in the range of 300 to 500 psi and the pressure in the bore below the ball element is in the range of 0 to 12,500 psi.

11. A well completion having a pipe string extending from a wellhead into a wellbore and a lubricator valve connected in the pipe string for intervening in the wellbore, the lubricator valve comprising:

a body having longitudinal bore;

a ball element rotatably mounted in the bore;

a seal retainer connected within the body and providing a valve seat positioned below the ball element relative to the wellhead, wherein the ball element rotates with respect to the valve seat between an open position opening the bore to fluid flow across the valve seat and a closed position blocking fluid flow at the valve seat thereby closing the bore;

an operator in connection between the ball element and a hydraulic control system, the operator moving the ball element between the open position and the closed position in response to the hydraulic control system, the operator not in fluid communication with the bore;

a pump-through piston having a first end connected to the operator and a second end in fluid communication with the bore above the ball element; and

a counter piston having an end connected to the operator and a second end in fluid communication with the bore below the ball element.

12. The well completion of claim 11, wherein the pump-through piston functions to move the ball element to the open position when a pressure differential across the ball element is in the range of about 600 psi to 8,400 psi.

13. The well completion of claim 11, wherein the pump-through piston and the counter piston function to move the ball element to the open position when a pressure differential across the ball element is in the range of about 300 psi to 500 psi.

14. The well completion of claim 11, wherein the pump-through piston and the counter piston function to move the ball element to the open position in response to a pressure in the bore above the ball element, when a pressure differential across the ball element is in the range of 300 to 500 psi and the pressure in the bore below the ball element is in the range of 0 to 12,500 psi.

15. The well completion of claim 11, wherein the pump-through piston functions to move the ball element to the open position in response to a pressure in the bore above the ball element.

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